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CORRELATION OF BODY SIZE OF MOTHS CAPTURED BY LIGHT TRAP WITH NINE ENVIRONMENTAL VARIABLES

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ABSTRACT. A single light trap in southern Georgia, USA, operated 29 times for two consecutive days over a 13-month period, captured almost 12,000 moths in six body length categories. Increasing size of moths was related to decreasing number of individuals captured. The smallest moths were the most frequently captured from late spring to early fall, and the least frequently captured at other times of the year. The smallest size (<6 mm) showed capture values widely divergent through time, whereas the intermediate category (11–15 mm and 16–20 mm) size values were the least divergent through time, suggesting that the smallest sized moths were the group most affected by environmental variables. The largest size categories, 21–25 mm and 26–30 mm, represented less than four percent of the total captures and were most frequently captured during the coldest temperatures and during rain. Environmental conditions the six days prior to trap operation were not consistently similar to those conditions prevailing during trap operation and in some cases did affect trap captures. Maximum temperature during trap operation was the best single explanatory variable for the occurrence of all captured moths, whereas minimum temperatures during trap operation was the best explanatory variable for the smallest size class, and rain prior to trap operation was the best single explanatory variable for the intermediate size classes.

Additional key words: size relationships, environmental factors

Humans have been watching insects attracted to light since at least the acquisition of fire. Since then, although many refinements have occurred in man's production of light, humans are still attempting to understand the factors associated with the attraction of insects to light. One part of that attempt has been the use of light traps to capture nocturnal insects, with an accumulating extensive research literature examining the reasons insects are attracted to light and under what conditions capture occurs (Hienton 1974). More recent investigations have studied the attractive properties of light (Eguchi *et al*. 1982), the types of insects attracted to light (Muirhead-Thomson 1991), and the effects of numerous factors on the capture of insects, particularly moths, at light traps. Such variables have included trap type and location (Hartstack 1979), habitat (Butler *et al*. 1999), season (Taylor 1986), yearly characteristics (White 1991), latitude (Bowden 1984), temperature (Dreisig 1986), relative humidity (Mizutani 1984), and the amount of moon illumination (Nowinszky *et al*. 1979), rainfall (Tucker 1983), and wind (McGeachie 1989).

In all of these studies mentioned, what has not explicitly been examined is the role of insect size as it relates to capture frequency and the influence of environmental factors. Believing, as Calder (1984) has stated, that "any biological study must first consider size as the most significant characteristic of an animal", my first project involving populations of nocturnal moths was to examine the effect of various environmental variables on different sizes of moths captured at light traps. The following study, using a single light trap, attempts to determine the relationship between nine environmental factors, occurring before and during trap operation, and the size of the captured moth.

MATERIALS AND METHODS

The collection site was located in Tifton, Tift Co., GA, one mile from the University of Georgia Coastal Plain Experiment Station. The light trap was an omnidirectional, gravity-type trap with four vertical baffles that surrounded a 15-W black light lamp and was mounted vertically 5 feet above ground over a 30 cm diameter funnel to which was attached a collecting can containing different sized mesh separating screens. The trap was located at the interface of a 1-acre second-growth woodland and a 1-acre pecan plantation with a mowed grass floor. The site was surrounded by an established (>20 yr) residential neighborhood with large lots, many mature trees, streams nearby, and minimal vehicular traffic. Nine environmental variables that might affect the capture of moths at a light trap were recorded during trap operation and the preceding six days and included: 1) temperature (^{0}C) - minimum and maximum, (2) rainfall (cm) - total amount in period, (3) wind (meters/sec.) - mean daily, (4) moon phase (0 = new, 1/4, 1/2, 3/4, 1 = full). Temperature values were obtained on-site with a maximum-minimum thermometer, rainfall and wind values were obtained from the adjacent experiment station official weather records, and moon phases were calculated from a local almanac. The six day period preceding a light trap sampling period represents the shortest interval in the entire study between consecutive sampling periods and thus was chosen as the standard interval of analysis before all sampling periods.

TABLE 1. Total number of moths captured in each size class in 29 sampling periods from 28 March 1981 to 7 May 1982 at Tifton, Tift Co., GA.

Size Class (mm)	Range of Values	Total No.	% of total
< 6	0-878	5180	43.2
6-10	2-526	3394	28.3
11-15	6-488	2268	18.9
16-20	2-97	747	6.2
21-25	0-34	330	2.8
26-30	0-12	68	0.6
Totals		11,987	100.0

The light-trap was operated approximately every two weeks from 2 hours before sunset to 1 hour after sunrise for two consecutive nights, for a total of 29 sample periods beginning 28 March 1981 and ending 7 May 1982. The contents of the trap container were bagged and frozen each morning, for subsequent processing. Later, after thawing and sorting, each moth was placed against a marked scale to determine its body length and its placement in one of six size categories (all in mm): <6, 6–10, 11–15, 16–20, 21–25, 26–30. Data from the two consecutive nights of trap operation were combined into one sample, with subsequent entry into an IBM main-frame and analysis by SAS GLM procedures.

RESULTS

From 28 March 1981 to 7 May 1982, 11,987 moths were captured during 29 sampling periods. Arranged by size categories, decreasing size was related to increasing numbers of individuals captured (Table 1). Combining the 29 sampling periods into 15 composite periods (Table 2) shows that the smallest size moth was the most frequently collected from mid-May to early September and then again from the following mid-April to early May. Members of this size class were some of the least frequently collected at other times of the year.

Table 3 examines within a size category the amount of variability in the mean number of captures through time, expressed as a ratio of the lowest value to the highest value. The 15 composite periods show that the 16–20 mm size category has mean capture values with the smallest difference between the lowest and the highest values through the entire 13-month period, with the <6 mm size category showing mean capture values widely divergent through time.

Nine environmental variables were monitored during the 13-month sampling period. Table 4 indicates that environmental conditions the six days prior to trap operation were sometimes substantially different from days when the light trap was operating. For the entire 13-month period, minimum temperatures were lower and total rainfall was greater prior to trap operation, whereas maximum temperatures and daily wind were about the same during and before trap operation. Considering the entire 13-month period, only some of the nine environmental variables were significantly correlated. In a 9×9 paired correlation matrix yielding 36 possible correlations, there are 6 positive and 6 negative correlations that are statistically significant (Table 5). Minimum temperatures during trap operation are significantly correlated with maximum temperatures (positive) and wind (negative) during the same period, and with minimum and maximum temperatures (positive) during the prior six days. Maximum temperatures during trap operation are significantly correlated with wind (negative) during the same period and with minimum and maximum temperatures (positive) and rain (negative) during the prior six days. Minimum temperatures during the six days prior to trap operation are significantly correlated with maximum temperatures (positive) and with wind and rain (negative) during the same period. Maximum temperatures during the six days prior to trap operation are significantly correlated (negative) with wind during trap operation.

An attempt to determine by stepwise regression the best explanatory model for the occurrence during the entire 13-month sampling period of all moth size classes indicated that maximum temperatures during trap operation was the best single explanatory variable (Table 6). Adding moon phase produced the best two-variable model and adding the rain variable during trap operation produced the best three-variable model. For the various size classes, the best explanatory model using only one variable was minimum temperatures during trap operation for the <6 mm class, maximum temperatures during trap operation for the 6–10, 21–25, and 26–30 mm size classes, and rain during the prior six days for the 11–15 and 16–20 mm size classes (Table 6).

DISCUSSION

Methodology considerations. Body mass or body volume values are commonly used in studies of animal assemblages (Blackburn *et al*. 1993; Siemann *et al*. 1999). In the present study, body length, rather than body mass values, was obtained for the captured moths. Attempting to weigh each moth, besides being more time consuming, would have introduced considerable variation due to the different states of dehydration present in samples. It has been demonstrated with

TABLE 2. Mean number of moths captured and percent of total capture per two consecutive nights in six size classes during 15 composite sampling periods (numbers captured read within rows and within columns; percent values read within rows; two trap nights = one sampling interval, two sampling intervals = one composite sampling period).

Sampling intervals	Period #	Trap nights	<6mm	6–10	11–15	16–20	21–25	26– 30	Mean Total
28–30 Mar; 4–6 Apr	1	4	0.5 0.7%	10 13.5	30 40.5	25 33.8	6 8.1	2.5 3.4	74.0
11–13 Apr; 18–20 Apr	2	4	18 8.3	49 22.5	107.5 49.3	29 13.3	12 5.5	2.5 1.1	218.0
25–27 Apr; 2–4 May	3	4	46 16.6	90 32.4	104.5 37.7	26.5 9.5	8.5 3.1	2 0.7	277.5
9–11 May; 16–18 May	4	4	175 47.5	104.5 28.4	66.5 18.0	11.5 3.1	10 2.7	1 0.3	368.5
23–25 May; 30 May–1 Jun	5	4	505.5 60.0	178 21.1	98 11.6	34.5 4.1	21 2.5	5 0.6	842.0
15–17 Jun; 30 Jun–2 Jul	6	4	559 71.6	156.5 20.1	38 4.9	21 2.7	4.5 0.6	1.5 0.2	780.5
16–18 Jul; 31 Jul–2 Aug	7	4	130 24.5	228.5 43.0	93 17.5	37.5 7.1	34 6.4	8 1.5	531.0
16–18 Aug; 1–3 Sep	8	4	484 54.7	311.5 35.2	57 6.4	12.5 1.4	17 1.9	3.5 0.4	885.5
15–17 Sep; 30 Sep–2 Oct	9	4	240.5 29.9	233.5 29.0	259 32.2	54 6.7	16 2.0	1.5 0.2	804.5
17–19 Oct; 4–6 Nov	10	4	26.5 10.1	95 36.2	97.5 37.1	39 14.9	4 1.5	0.5 0.2	262.5
18–20 Nov; 24–26 Dec	11	4	2 5.8	7.5 21.7	16.5 47.9	7.5 21.7	2 2.9	0 0	34.5
20–22 Jan; 18–20 Feb	12	4	1.5 3.1	9 18.4	24.5 50.0	9.5 19.3	4.5 9.2	0 0	49.0
11–13 Mar; 1–3 Apr	13	4	18.5 10.9	54 31.9	63 37.2	23 13.5	8.5 5.0	2.5 1.5	169.5
14–16 Apr; 28–30 Apr	14	4	174.5 50.4	90.5 26.2	45 13.0	22.5 6.5	7 2.0	1.5 0.4	341.0
5–7 May	15	2	407 58.1	159 22.7	68 9.7	41 5.8	22 3.1	4 0.6	701.0
28 Mar 81 – 7 May 82		58	2744.8 43.2%	1698.8 28.3	1133.7 18.9	380 6.2	163.5 2.8	33.3 0.6	6339.0

other organisms that "linear measurements, having lower coefficients of variation, were preferable over use of body mass to express size" (Rising & Somers 1989). Body length is typically used in research as a measure of size in most winged insects, with Lepidoptera as the principle exception (e.g. Novotny & Kindlmann 1996). In Lepidoptera studies, body length is typically not considered an adequate measure of organism size; wing length (e.g. Summerville *et al*. 2006) or wing span (e.g. Nieminen *et al*. 1999) is the preferred metric. Support for this view was provided by Miller (1977), who within a single family of Lepidoptera demonstrated that forewing length was a good substitute for biomass as a size index. As documented by Greenewalt (1962),

TABLE 3. Ratio of the lowest to the highest mean capture value for each moth size within the entire 15 composite sampling period (capture values from Table 2).

Moth Size (mm)	Lowest Mean Captured	Highest Mean Captured	Capture Ratio	Capture Rank
<6	0.5	559	1:1118	6
6–10	6	311.5	1:52	4
11–15	13.2	259	1:19.7	2
16–20	6	54	1:9	1
21–25	0.8	22	1:27.5	3
26–30	0.1	5.3	1:53	5
Total	4.4	201.8	1:45.6	

TABLE 4. Environmental variable values (variable followed by the number '1' represents events occurring while the light trap was in operation; the number '2' represents events occurring the preceding six days).

Variable	Mean	Std. Dev.	Range
Min Temp 1	14	5.08	4–23
Min Temp 2	8.97	8.61	-13–23
Max Temp 1	28.89	4.45	20–38
Max Temp 2	30.89	3.68	23–37
Rain 1	0.41	0.94	0–3.8
Rain 2	3.44	3.86	0–13.4
Wind 1	52.48	22.84	27–130
Wind 2	53.62	13.52	28–80
Moon	0.50	0.36	0–1

TABLE 5. Significant correlations between environmental variables (variable followed by the number '1' represents events occurring while the light trap was in operation; the number '2' represents events occurring the preceding six days).

Variable 1	Variable 2	Correlation Coefficient.	Probability
Min Temp 1	Min Temp 2	+ 0.81	< 0.001
Min Temp 1	Max Temp 1	+ 0.71	< 0.01
Min Temp 1	Max Temp 2	+ 0.69	< 0.001
Min Temp 1	Wind 1	- 0.44	< 0.02
Max Temp 1	Min Temp 2	+ 0.65	< 0.001
Max Temp 1	Max Temp 2	+ 0.66	< 0.001
Max Temp 1	Wind 1	- 0.60	< 0.001
Max Temp 1	Rain 2	- 0.39	< 0.04
Min Temp 2	Max 2	+ 0.71	< 0.001
Min Temp 2	Wind 2	- 0.43	< 0.02
Min Temp 2	Rain 2	- 0.56	< 0.002
Max Temp 2	Wind 1	- 0.47	< 0.01

however, there is a large degree of divergence from a standard ratio of wing length to body weight among and between the various families of Lepidoptera. Thus in studies involving a wide taxonomic diversity, wing length/span may not be the best measure of size. Choosing either body or wing metrics for this study does unfortunately introduce certain biases. Differences in moth wing size would likely be most affected by wind (McGeachie 1989), and differences in body size would most likely be influenced by temperature (Heinrich 1993).

Environmental variables. Moon. The role of moon illumination on light trap captures of moths has been well documented in many studies (e.g., Bowden 1984; Yela & Holyoak 1997). In simple terms, the brighter the moon illumination, the less visible to moths is light from a trap, leading to reduced numbers of captures. In the present study, the amount of moon illumination was not correlated with any of the other environmental variables (Table 5). Moon illumination, however, did become a 2nd order variable in explanatory models for numbers of moths captured (Table 6).

Rain. Because sample nights were chosen based on the likelihood of no rain, it is not surprising that during the sampling periods there were no significant correlations between rain and other environmental variables or numbers and sizes of moths captured. The well-known depressive effect of rainfall on ambient temperature (Rosenberg *et al*. 1983) is confirmed in this study, as the occurrence of rain in the six days prior to sampling periods was significantly correlated (negative) with the minimum temperature during that period and with the maximum temperature of the subsequent sampling period (Table 5). In explanatory models for sizes and numbers of moths captured, rain was a 3rd order variable for the entire set of captures and a 1st order variable for several size classes (Table 6).

Wind. Both during and before the moth sampling periods, wind was significantly correlated (negative) with minimum and maximum temperatures (Table 5). Wind would be expected to lower temperatures, due both to increased evaporative cooling and the association with changing weather conditions. Given that the trap location was in a reasonably protected location, wind would not be expected to have a significant impact on numbers of moths captured. The location of the wind-monitoring equipment at the nearby Experiment Station, however, was in a more exposed location, producing wind values that when applied to the trap location, over-emphasized the potential impact of wind. Although wind was not a 1st order variable in explanatory models for numbers and sizes of moths captured, it was a 2nd or 3rd order

TABLE 6. The number of moths captured in each size class in 29 sampling periods regressed against nine environmental variables, producing best explanatory models based on one or two or three variables (variable followed by the number '1' represents events occurring while the light trap was in operation; the number '2' represents events occurring the preceding six days).

Size (mm)	Best 1 variable	R^2	Prob >F	Best 2 variables	R^2	Prob > F	Best 3 variables	R^2	Prob > F
<6	Min Temp 1	0.22	0.012	Min Temp 1 Rain 1	0.32	0.004 0.068	Min Temp 1 Rain 1 Moon	0.43	0.001 0.031 0.041
6–10	Max Temp 1	0.28	0.004	Max Temp 1 Moon	0.33	0.002 0.178	Min Temp 1 Rain 1 Wind 2	0.40	0.030 0.025 0.042
11–15	Rain 2	0.14	0.051	Wind 2 Rain 2	0.18	0.255 0.042	Rain 1 Rain 2 Wind 2	0.27	0.105 0.189 0.093
16–20	Rain 2	0.25	0.007	Rain 2 Moon	0.31	0.003 0.145	Rain 1 Rain 2 Moon	0.37	0.148 0.004 0.109
21–25	Max Temp 1	0.29	0.003	Max Temp 2 Max Temp 1	0.35	0.139 0.001	Max Temp 2 Max Temp 1 Min Temp 2	0.40	0.067 0.024 0.172
26–30	Max Temp 1	0.35	0.001	Max 1 Wind 1	0.41	0.001 0.100	Wind 1 Max Temp 1 Max Temp 2	0.48	0.044 0.019 0.082
Total	Max Temp 1	0.23	0.009	Max Temp 1 Moon	0.33	0.002 0.061	Max Temp 1 Rain 1 Moon	0.39	0.002 0.153 0.049

variable in several specific size models (Table 6).

Temperature. Minimum temperatures before and during sampling periods were significantly correlated with maximum temperatures before and during sampling periods, as well as with wind and rain (Table 5). Moth activity occurred throughout the range of observed temperatures (4 to 38^{0}C), though the extremes of temperature may have inhibited flight somewhat. Minimum temperatures during the sampling periods were a 1st order explanatory variable only for the smallest (<6 mm) size class. This was not unexpected, given that a small object has more surface area for its volume than a larger one, leading to the smaller object losing heat faster (Calder 1984). Thus the smallest moths were most likely to not be flying at the lowest temperatures. Although there are some small winter-active moths that can fly continuously at ambient temperatures of 5^{0}C (Heinrich 1987), they are uncommon and do not occur in Georgia (Schweitzer 1974).

Body size. At the start of this study, it was thought that the use of body length rather than wing length or wing span as a measure of moth size would probably have an effect on the relative importance of temperature; that is, body length would probably be more sensitive to variables affecting body metabolism, such as temperature. It is well established that there is minimal heat transfer to and from the wings and the body of lepidopterans (Kammer & Brachi 1973), indicating the key role of the body in both generating heat necessary for body functions and as the primary portion of the complete organism most affected by environmental temperature. If wing length or wing span had been used as the size metric, rather than body length, the results of this study would probably have been different. Small moths tend to have relatively larger wings than large moths, primarily due to their difficulty in maintaining sufficiently high thoracic temperatures necessary for flight; larger wings compensate for smaller mass (i.e., low wing-loading) and allow flight at the necessarily lower thoracic temperature (Bartholomew & Heinrich 1973).

The size distribution illustrated by Table 1—decreasing abundance as individual size increases—is the same pattern found in many animal assemblages (e.g., Blackburn *et al*. 1993). What is not typically seen is the relation of size to temperature. Minimum temperature during sampling periods best explains the occurrence of the smallest moths, and maximum temperatures during sampling periods best explains the occurrence of the largest moths, but temperature has no explanatory value for the occurrence of the intermediate-sized moths (Table 6). The effect of temperature may also be involved in the variability of

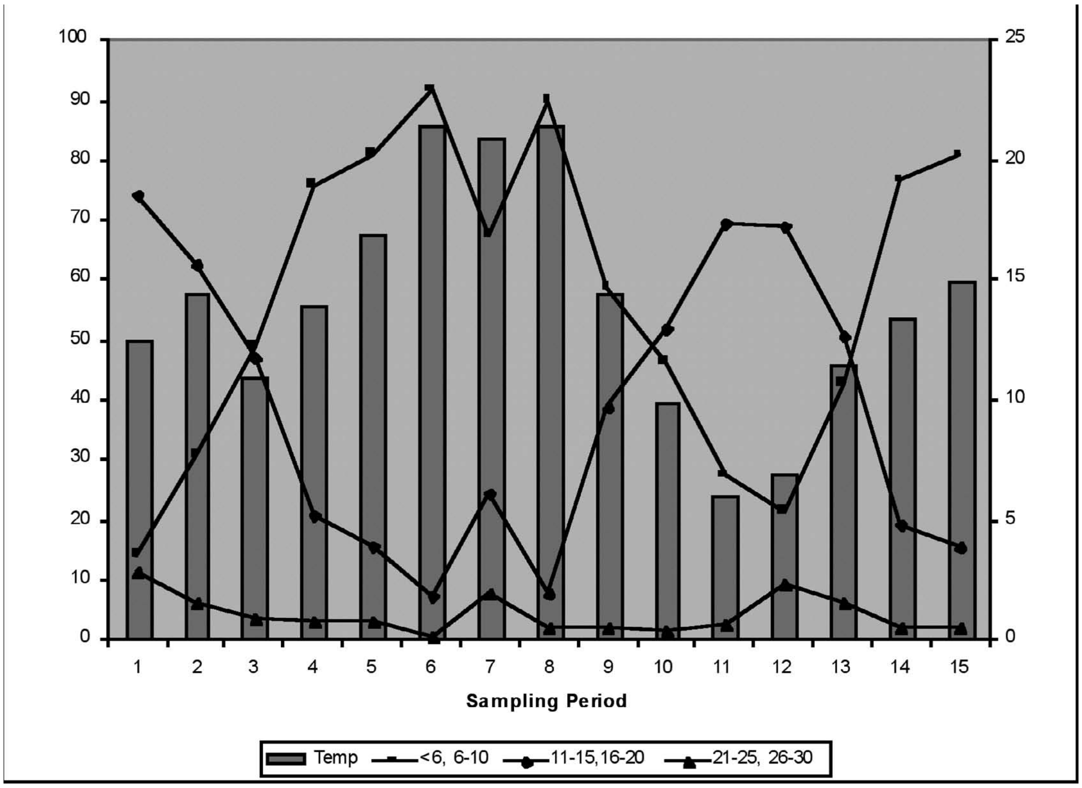

FIG. 1. Percentage of moths captured in three size categories in 15 sampling periods, with concurrent minimum temperatures.

capture numbers within a size category. The smallest- and largest-sized moths have the greatest range of capture numbers during the sampling periods and the intermediate-sized moths have the least variability in capture numbers (Table 3). This suggests that the intermediate-sized moths have, through time, a relatively constant population size, and/or a population relatively unaffected by changes in the various environmental conditions that were monitored. The order-of-magnitude difference in capture number variability between the smallest-sized (<6 mm) moths and all other sized moths (Table 3) suggests that the smallest-sized moths are more affected by environmental variables than any of the other sizes.

Does this study indicate that there is an optimal size for "successful" moths at this location? Yes and no. If success is defined as the largest population, then the smallest moths are the optimal size. If success is defined as the most stable population through time, and thus perhaps the group least affected by environmental variables, then the intermediate-sized moths are the optimal size.

When the six size categories are consolidated into three, and a plot is created of sampling period versus percentage of the size class in each sampling period (Fig. 1), the smallest moths are most abundant in the warmer periods of the year and the intermediate-sized moths are most abundant in the cooler periods. The largest size class never exceeded 12 percent of the total moths captured in any period, whereas the smallest size class peaked at 91 percent and the intermediate size class peaked at 74 percent. Figure 1 also illustrates the impact that rain can have on the capture of moths in a light trap, and on the subsequent analyses. Although there was a deliberate attempt to avoid sampling periods in which rain might occur, this was not possible for the 31 July–2 August period. The occurrence of rain both before and during that sampling period depressed the capture frequency of the smallest-sized moths and increased that of the intermediate-sized moths (Fig. 1). These two periods were sufficiently important in the entire 13 month study for rain to become the most important parameter in the explanatory models for the two intermediate-size categories (Table 6).

In general, the results of this study are compatible with the pioneering study in England of C.B. Williams (1940), who demonstrated that temperature in winter (November to April) was the most important factor affecting insect capture (of all sizes) at light traps, and that rainfall in summer (May to October) was the most important factor. Other trends demonstrated by numerous studies (e.g., McGeachie 1989) are also supported, to include (1) increases in mean illumination and mean wind speed are associated with a decreased light-trap catch of moths (of all sizes), and (2) increases in mean temperature are associated with an increased catch.

Without knowledge of each species and its relevant biology included in this assemblage, it is merely conjecture to outline the relationships between various environmental parameters and the individual size of groups of moths captured. This study, though not specifically addressing the metabolic characteristics of the various sizes of moths captured, does support the general conclusion that the smallest sized moths would be most affected by environmental temperatures lower than about 30^0C, and that there may be an optimum size of moth best suited for a particular set of environmental variables (Heinrich 1993).

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Please see Appedix A & B on the next two pages

APPENDIX A. Light trap capture data, 28 March 1981–7 May 1982, Tifton, Tift Co., GA.

Sample Dates	TrapNights	<6 mm	6–10 mm	11–15 mm	16–20 mm	21–25 mm	26–30mm	Total
28 Mar–30 Mar 81	2	1	7	17	13	3	1	42
4 Apr–6 Apr	2	0	13	43	37	9	4	106
11 Apr–13 Apr	2	3	36	62	27	12	3	143
18 Apr–20 Apr	2	33	62	153	31	12	2	293
25 Apr–27 Apr	2	43	50	119	26	7	2	247
2 May–4 May	2	49	130	90	27	10	2	308
9 May–11 May	2	165	103	95	16	14	0	393
16 May–18 May	2	185	106	38	7	6	2	344
23 May–25 May	2	713	260	107	44	25	6	1155
30 May–1 Jun	2	298	96	89	25	17	4	529
15 Jun–17 Jun	2	242	170	15	11	6	3	447
30 Jun–2 Jul	2	876	143	61	31	3	0	1114
16 Jul–18 Jul	2	122	237	109	35	34	12	549
31 Jul–2 Aug	2	138	220	77	40	34	4	513
16 Aug–18 Aug	2	90	97	14	15	29	5	250
1 Sep–3 Sep	2	878	526	100	10	5	2	1521
15 Sep–17 Sep	2	27	39	30	11	3	0	110
30 Sep–2 Oct	2	454	428	488	97	29	3	1499
17 Oct–19 Oct	2	45	141	128	28	4	1	347
4 Nov–6 Nov	2	8	49	67	50	4	0	178
18 Nov–20 Nov	2	4	13	14	12	2	0	45
24 Dec–26 Dec	2	0	2	19	3	0	0	24
20 Jan–22 Jan 82	2	0	9	6	2	2	0	19
18 Feb–20 Feb	2	3	9	43	17	7	0	79
11 Mar–13 Mar	2	4	11	43	17	4	1	80
1 Apr–3 Apr	2	33	97	83	29	13	4	259
14 Apr–16 Apr	2	183	92	57	26	7	1	376
28 Apr–30 Apr	2	166	89	33	19	7	2	316
5 May–7 May	2	407	159	68	41	22	4	701
Totals		5180	3394	2268	747	330	68	11987

APPENDIX B. Environmental values, 28 March 1981–7 May 1982, Tifton, Tift Co., GA (temperature = degrees centigrade; rainfall = centimeters, total amount in period; wind = mean meters per day; moon = 0 - new, 1 – full; identification numbers with letter 'S' represent sample periods when light trap was operating).

Please see Appendix B on the next page

Appendix B. Environmental values, 28 March 1981–7 May 1982, Tifton, Tift Co., GA

I.D. No.	Sample Period	Temperature Min–Max	Rainfall	Wind	Moon
1	23 Mar–28 Mar	3 - 23	0.02	35	
1S	28 Mar–30 Mar	12 - 24	0.28	130	0.50
2	30 Mar –4 Apr	9 - 33	3.63	61	
2S	4 Apr–6 Apr	13 - 22	0.30	90	0.00
3	6 Apr–11 Apr	8 - 31	0.00	55	
3S	11 Apr–13 Apr	14 - 31	0.00	39	0.50
4	13 Apr–18 Apr	12 - 33	0.00	49	
4S	18 Apr–20 Apr	15 - 32	0.00	49	1.00
5	20 Apr–25 Apr	10 - 30	1.45	72	
5S	25 Apr–27 Apr	12 - 29	0.00	36	0.50
6	27 Apr–2 May	11 - 32	0.00	48	
6S	2 May –4 May	10 - 27	0.00	45	0.00
7	4 May–9 May	11 - 31	2.74	48	
7S	9 May–11 May	15 - 26	0.00	72	0.50
8	11 May–16 May	8 - 30	0.00	71	
8S	16 May–18 May	13 - 32	0.00	45	1.00
9	18 May–23 May	10 - 34	0.00	68	
9S	23 May–25 May	16 - 32	0.00	48	0.50
10	25 May–30 May	16 - 33	1.75	65	
10S	30 May–1 Jun	18 - 33	0.00	40	0.00
11	1 Jun–15 Jun	23 - 35	2.51	55	
11S	15 Jun–17 Jun	23 - 35	0.20	29	1.00
12	17 Jun–30 Jun	16 - 36	0.41	52	
12S	30 Jun–2 Jul	20 - 32	0.30	42	0.00
13	2 Jul–16 Jul	19 - 37	3.30	40	
13S	16 Jul–18 Jul	23 - 38	0.00	42	1.00
14	18 Jul–31 Jul	20 - 37	4.37	46	
14S	31 Jul–2 Aug	19 - 32	3.78	35	0.00
15	2 Aug–16 Aug	20 - 33	5.36	34	
15S	16 Aug–18 Aug	22 - 34	2.16	39	1.00
16	18 Aug–1 Sep	17 - 32	8.03	39	
16S	1 Sep–3 Sep	21 - 34	0.00	28	0.25
17	3 Sep–15 Sep	18 - 35	2.82	28	
17S	15 Sep–17 Sep	17 - 27	2.77	43	1.00
18	17 Sep–30 Sep	9 - 33	0.00	36	
18S	30 Sep–2 Oct	12 - 31	0.00	27	0.25
19	2 Oct–17 Oct	9 - 30	1.88	51	
19S	17 Oct–19 Oct	7 - 29	0.00	66	0.75
20	19 Oct–4 Nov	8 - 26	3.60	63	
20S	4 Nov–6 Nov	13 - 23	0.43	48	0.50
21	6 Nov–18 Nov	2 - 26	5.08	47	
21S	18 Nov–20 Nov	6 - 27	0.00	65	0.50
22	20 Nov–24 Dec	-8 - 27	12.73	60	
22S	24 Dec–26 Dec	6 - 20	1.63	75	0.00
23	26 Dec–20 Jan	-13 - 27	13.41	66	
23S	20 Jan–22 Jan	10 - 23	0.00	36	0.25
24	22 Jan–18 Feb	-5 - 27	12.73	71	
24S	18 Feb–20 Feb	4 - 25	0.00	82	0.25
25	20 Feb–11 Mar	-2 - 28	2.87	56	
25S	11 Mar–13 Mar	9 - 29	0.00	29	0.75
26	13 Mar–1 Apr	4 - 34	2.82	65	
26S	1 Apr–3 Apr	14 - 31	0.00	70	0.50
27	3 Apr–14 Apr	2 - 27	4.75	59	
27S	14 Apr–16 Apr	15 - 30	0.00	48	0.50
28	16 Apr–28 Apr	9 - 29	3.51	80	
28S	28 Apr–30 Apr	12 - 22	0.00	76	0.50
29	30 Apr–5 May	14 - 27	0.00	35	
29S	5 May –7 May	15 - 28	0.00	48	1.00